Northern Goshawk Surveys on the Kanuti National Wildlife Refuge, 2012

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Abstract

*We surveyed Northern Goshawks (*Accipiter gentilis*) on three rivers on Kanuti National Wildlife Refuge (KNWR) in 2011 and 2012 using a protocol slightly modified from that developed by the US Forest Service for terrestrial-based surveys in the coterminous states. We broadcast goshawk alarm calls at 79 stations over 45 km of the Kanuti River in 2011 and 2012, and 164 stations over 90 km of the Jim and South Fork Koyukuk Rivers in 2012. Response rates were low, with four and six responses on Kanuti River in 2011 and 2012, respectively, and five responses on Jim and South Fork Koyukuk Rivers in 2012. Because of the close proximity of several of the stations where goshawks responded, we suspect some of these birds were from the same territories. We elicited responses from species other than goshawks during our survey, as well. Eight different species responded at 41 stations on Kanuti River, with American Robins, red squirrels and Gray Jays the most frequent respondents. We elicited responses from 16 other species at 102 stations on the Jim and South Fork Koyukuk River route with Spotted Sandpipers, red squirrels and Gray Jays responding most frequently. We also present information on observations of species made opportunistically during both surveys in 2012.*

Introduction

We initiated a survey of Northern Goshawks (*Accipiter gentilis*) on Kanuti National Wildlife Refuge (KNWR) in 2011 (Craig and Spindler 2011). The purpose of the survey was to develop a method to monitor the abundance and distribution of nesting goshawks in Kanuti's remote setting using broadcast calls, a common survey technique in the coterminous states. Goshawks are of particular interest because very little is known about their status on KNWR, or in the North American Arctic in general. Furthermore, goshawks usually nest in stands of large, mature trees that have a closed canopy (≥60% canopy cover) and an open understory (Squires and Reynolds 1997). Rupp and Springsteen (2009) have predicted that the fire regime on the Refuge

will be altered in the future because of climate change. This may lead to a reduction in suitable nesting habitat for Northern Goshawks if old growth timber patches decline.

In 2011 we surveyed approximately 45 km of the Kanuti River for nesting goshawks using a protocol developed by the US Forest Service (Woodbridge and Hargis 2006). We made one departure from this protocol by using a motorized skiff, rather than walking or using a terrestrial vehicle to move between survey stations. We found that the protocol with our modification was well suited for surveying goshawks and elicited four responses out of the 79 stations that we called along the river.

In 2012 we repeated the Kanuti River survey and conducted another similar survey along the Jim and South Fork Koyukuk Rivers. Herein, we present the results of these surveys and make recommendations for further work.

Study Areas

We conducted surveys along sections of three rivers on KNWR in 2012 (Fig. 1). From 21-22 June, we resurveyed the Kanuti River route, calling at the same stations and using the same techniques we employed the previous year. This survey began near Kanuti Cabin and continued downstream about 45 km. From 12–17 July we surveyed goshawks on sections of the South Fork Koyukuk and Jim Rivers. This survey route started at the Refuge's eastern boundary on the Jim River and continued downstream, first to the confluence with South Fork Koyukuk River, and then downstream to that river's confluence with the main Koyukuk River, a distance of about 90 km. Wildfires had modified habitat near both rivers. However, a greater proportion of the South Fork Koyukuk/Jim River survey route was in close proximity to burned areas than the Kanuti River survey route.

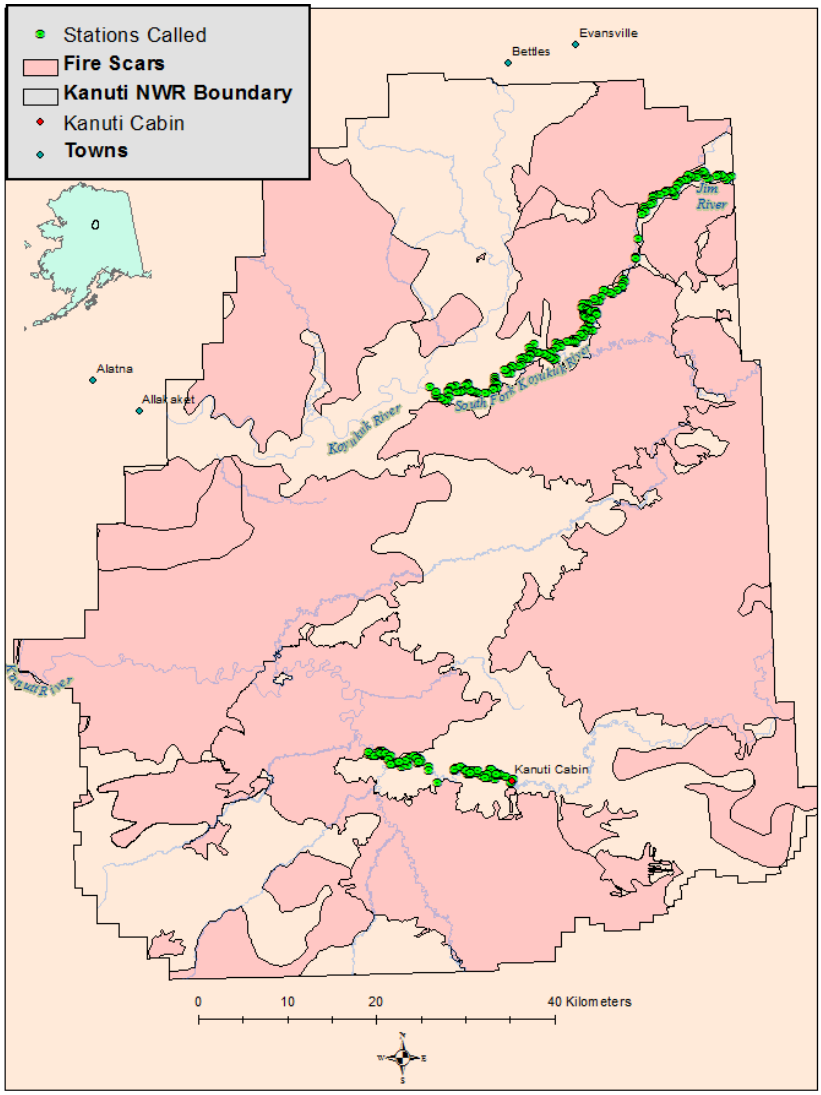

Figure 1. Locations of calling stations used during surveys of nesting Northern Goshawks in 2012 on portions of three rivers. Kanuti National Wildlife Refuge, Alaska.

Methods

The survey methods we used in 2012 on the Kanuti River route are described in Craig and Spindler (2011). Our survey methods on the South Fork Koyukuk/Jim Rivers route were similar, except we used non-motorized, inflatable boats, floating at current speed (circa 3-4 km/hr.) to conduct the survey.

On both rivers we selected calling stations based on three criteria; stations were: 1) along the river, 2) within 200 m of "old growth" timber patches that were at least 10 ha in size, and 3) were at least 200 m apart. On the South Fork Koyukuk/Jim River route, the resulting number of stations was so great that we could not complete the survey in the available time. Consequently, we randomly selected 17 stations within each of 10 segments of the river, and planned to call

only at those stations. However, when we conducted the survey, we found that some of these stations were unusable and established new stations. The reasons for these changes were:

- ambient conditions precluded their use because stations were located near noisy rapids;
- the river had changed course in several places since the maps we used to select stations *in laboratorium* were drawn. Where this occurred, we moved the calling stations to a place of appropriate habitat that was located close to the original, projected calling station, and recorded a new GPS location for that station;
- a new river channel crossed though appropriate nesting habitat that was downstream of an omitted, randomly selected station.

In all, we surveyed 79 stations on the Kanuti River survey route and 164 stations on the South Fork Koyukuk/Jim Rivers route. The GPS locations of stations called along Kanuti River are listed in Craig and Spindler (2011). The GPS locations of stations we called on the South Fork Koyukuk/ Jim Rivers are listed in Appendix 1.

In addition to recording the responses of goshawks to the broadcast alarm calls, we also noted the responses of other species to the calls. While there was some subjectivity in interpreting the behaviors of these animals, generally we ascribed a response to a bird or mammal if it appeared to move close to us immediately following a calling sequence, and/or emitted an alarm call of its own after we played a call. We attempted to record observations of other wildlife sightings made during the course of the surveys, and while in transit to and from the Kanuti survey area. These data are biased toward the larger, more visible species, but are consistent between survey areas. Appendix 2 contains the scientific names and codes for species discussed throughout this document.

Analysis

We plotted locations of all goshawk responses using GIS and examined inter-nest distances to better understand clustering and to detect potential double-counting of individuals. To evaluate the distribution of responses at stations by non-target species, we divided the survey routes into 3 segments, each containing an equal number of stations. In contrast, to examine the distribution of observations of non-target species, we divided each route into 3 segments of equal length because we recorded observed species both at calling stations and between them. In both cases, we numbered the segments furthest upstream "1" and the rest were numbered sequentially downstream.

We calculated Chi-Square goodness of fit tests for significance using Microsoft Office Excel 2010 (Chisq.Test function). The null hypothesis was that there was no difference among segments in the two survey areas in the distribution of species observed, and the responses to goshawk calls by non-target species (α=0.05; df=2). Expected values were determined by assuming that all responding and observed individuals were evenly distributed in each segment. Because the chi-square test is not reliable with small expected values, we disregarded data sets where the expected values were less than five in a river segment.

Results

Northern Goshawks.

In 2012 we detected Northern Goshawks in five locations during the South Fork Koyukuk/Jim River survey and six locations during the Kanuti River survey (Table 1; Fig. 2). Responses along the South Fork Koyukuk/ Jim Rivers were spatially clustered with four responses being within 5.2 km of each other (Fig. 3), three of which averaged only 1.9 ± 0.3 km (mean ± SD; range: 1.5 – 2.3km) apart. The remaining response was over 22 km from this area. Responses along the Kanuti River were also clustered with two responses each less than 0.7 km from the next station where we elicited a response. The remaining responses on Kanuti River averaged 4.3 ± 2.4 km apart (range: 2–7.9km).

Table 1. Response by Northern Goshawks to broadcast alarm calls during a nesting survey on portions of three rivers on Kanuti National Wildlife Refuge, Alaska in 2012.

Response*	Survey location	Station Number	Distance to nearest station with a response (km)
SGOS	SF Koyukuk/Jim Rivers	012GR-1	1.5
VGOS	SF Koyukuk/Jim Rivers	023GR-1	1.5
VGOS	SF Koyukuk/Jim Rivers	040GR-2	2.1
VGOS	SF Koyukuk/Jim Rivers	055GR-2	2.3
VGOS	SF Koyukuk/Jim Rivers	275GR-6	22.0
SGOS	Kanuti River	018G	0.7
VGOS	Kanuti River	037G	0.7
VGOS	Kanuti River	090G	3.0
BGOS	Kanuti River	200G	0.5
BGOS	Kanuti River	203G	0.5
SGOS	Kanuti River	226G	2.0

***SGOS – Aural detection of a Northern Goshawk**

***VGOS- Visual detection of a Northern Goshawk**

***BGOS – Both visual and aural detection of a Northern Goshawk**

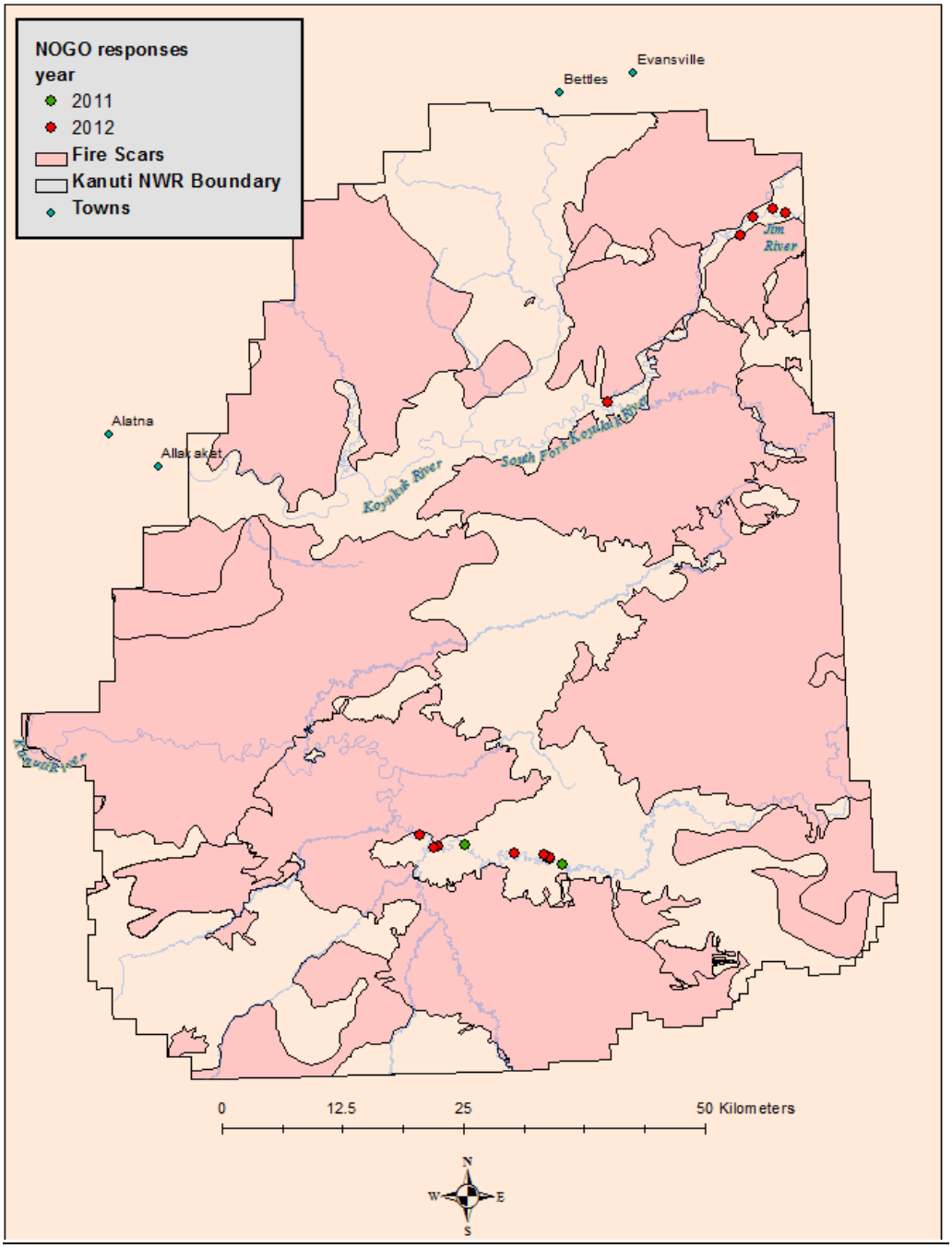

Figure 2. Locations where Northern Goshawks (NOGO) responded to broadcast alarm calls during surveys in 2011 and 2012 on portions of three rivers on Kanuti National Wildlife Refuge, Alaska.

We elicited responses from goshawks at four different locations in 2011. These were located in two different areas, with three of the responses clustered together; the greatest separation between these clustered responses was1.8 km, but two were only 0.4 km apart. This cluster of responses was separated from an isolated response by roughly 8.5 km. Interestingly, the clusters

of responses that we detected in 2011 and 2012 on Kanuti River all occurred within 0.8 km of each other.

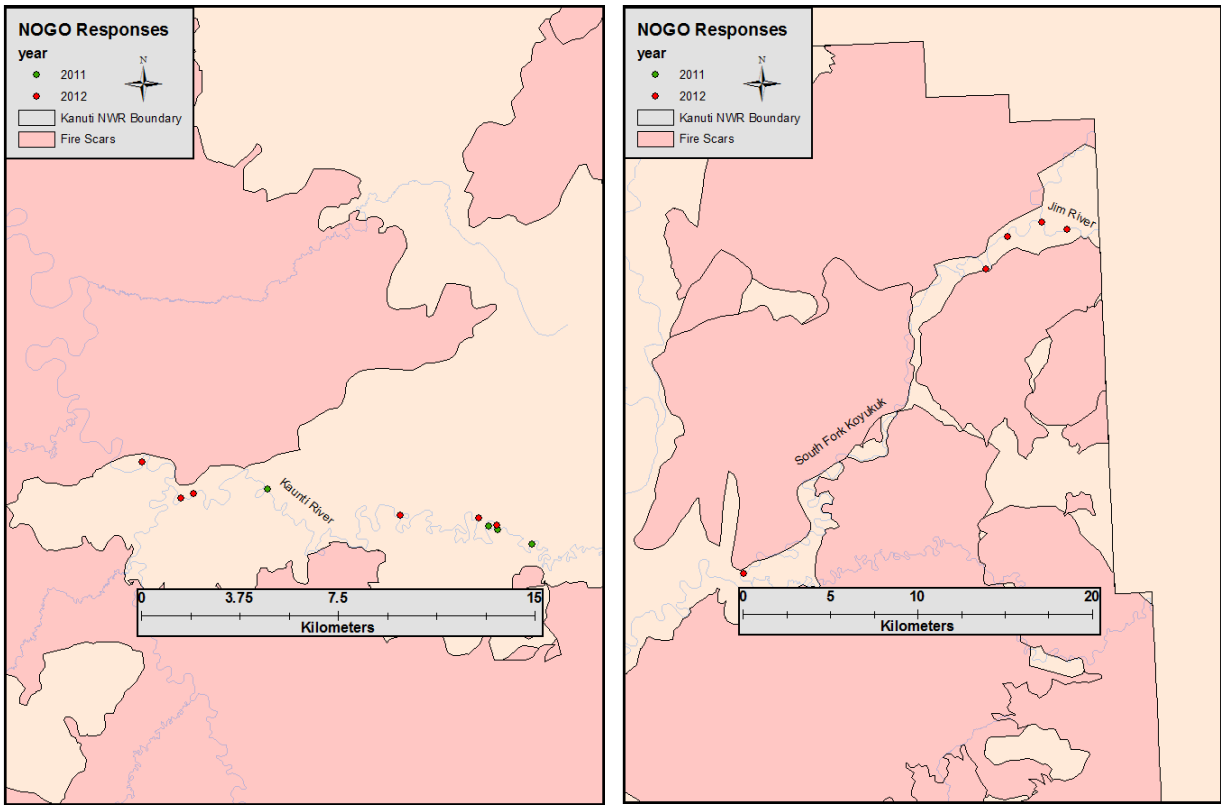

Figure 3. Enlarged maps showing locations where Northern Goshawks responded to broadcasted alarm calls in 2011 and 2012 on portions of three rivers on Kanuti National Wildlife Refuge, Alaska.

Responses by other species.

We elicited responses from species other than goshawks at 102 stations (62%) along the South Fork Koyukuk/ Jim Rivers. Of the 16 responding species, Spotted Sandpipers, red squirrels and Gray Jays responded most frequently (Fig. 4). Most (63%) of the 13 other species that responded to goshawk calls on the South Fork/Jim Rivers route were detected at ≤ 3 stations. Although, there were no significant differences in responses by species in relation to river segment, more Spotted Sandpipers responded along the lower South Fork Koyukuk River (Segment 3) than in the other two segments.

We elicited responses from species other than goshawks at 41 of the stations (52%) along the Kanuti River; American Robins, red squirrels and Gray Jays responded most frequently (Fig. 5). Like the South Fork Koyukuk/ Jim River route, most (63%) of the species that responded on the Kanuti River were detected infrequently (i.e. at ≤ 3 stations). However, unlike for the South Fork Koyukuk/ Jim River route, there was a significant departure from the expected distribution of responding robins, red squirrels, and for all responding species combined, among the three river segments (Table 2). Fewer robins and squirrels and fewer total responses occurred in the middle segment of the Kanuti survey route.

Figure 4. Responses of nontarget species to Northern Goshawk alarm calls along 3 segments of the South Fork Koyukuk and Jim Rivers in 2012. Kanuti National Wildlife Refuge, Alaska.

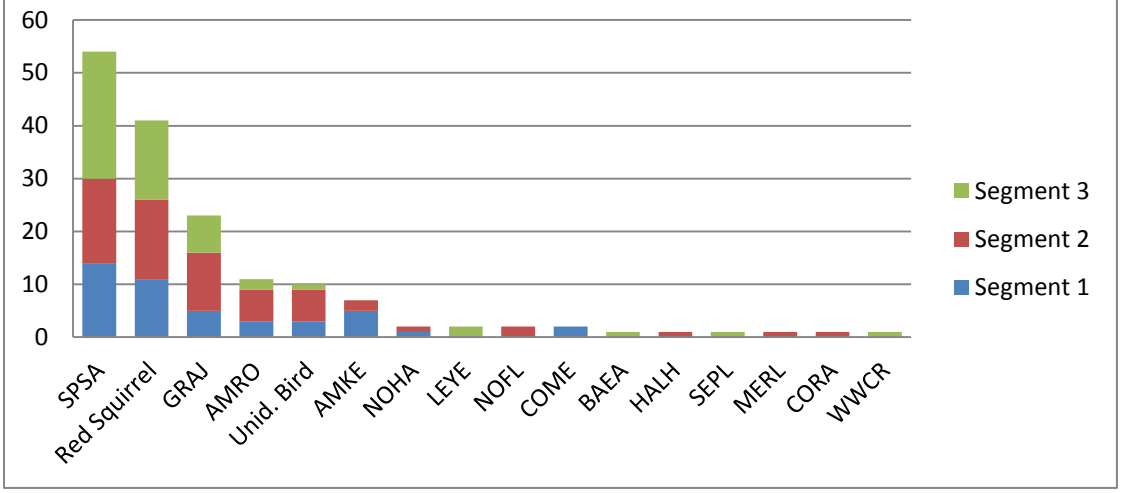

Figure 5. Responses by nontarget species to Northern Goshawk alarm calls along 3 segments of the Kanuti River in 2012. Kanuti National Wildlife Refuge, Alaska

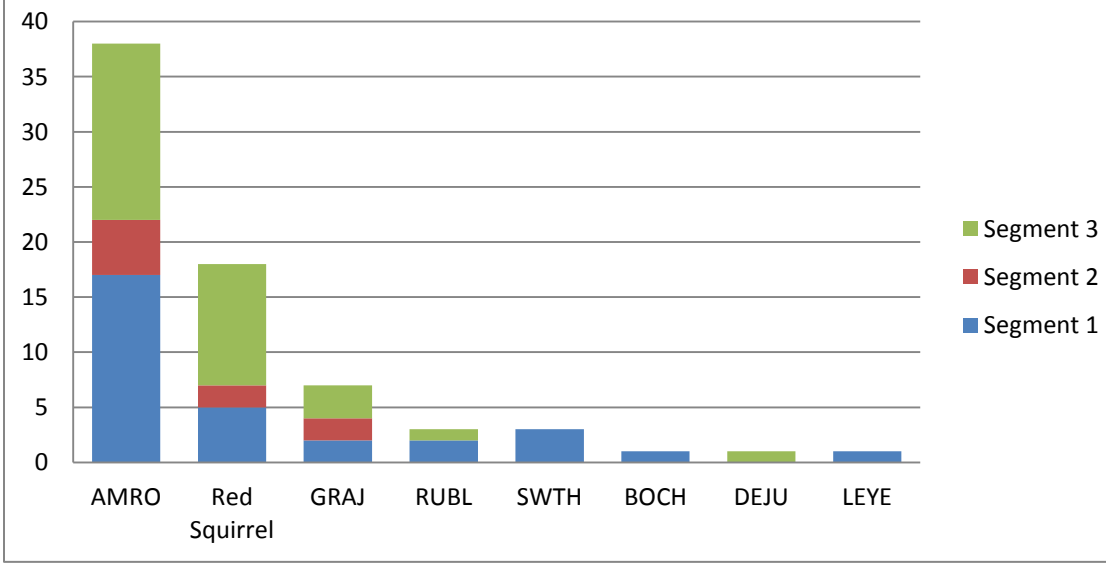

Table 2. Significant result of chi-square analysis of responses by non-target species to broadcast Northern Goshawk calls along 3 segments of the Kanuti River, 2012. Kanuti National Wildlife Refuge, Alaska.

Survey route	**Species**	**P value (α=0.05)**	**Comment**
Kanuti River	AMRO	0.030472	Fewer in Segment 2
Kanuti River	Red Squirrel	0.030197	Fewer in Segment 2
Kanuti River	Total No. responses	0.000875	Fewer in Segment 2

Observations of other species during surveys.

We recorded 30 species other than goshawks along the South Fork Koyukuk/ Jim River survey routes. Bald Eagles, Common Ravens, Canada Geese and Common Redpolls were the most commonly encountered species. We observed ≤ 3 individuals of most (70%) of the other species (Fig. 6). There was no significant difference in the number of observations by segment on this survey route. We observed 15 different species on Kanuti River during the goshawk survey. Beaver was the most frequently observed species, but we only spotted them five times, and all were on the upper-most river segment. We observed all other species ≤ three times on the Kanuti River (Fig. 7). When we combined the observations of all species, we found a significant difference in the number observed among the three segments on Kanuti River; we spotted more species on the lower river than on the two other river segments (Table 3).

Figure 6. Non-target species observed during a survey of Northern Goshawks along 3 segments of the South Fork Koyukuk and Jim Rivers in 2012. Kanuti National Wildlife Refuge, Alaska.

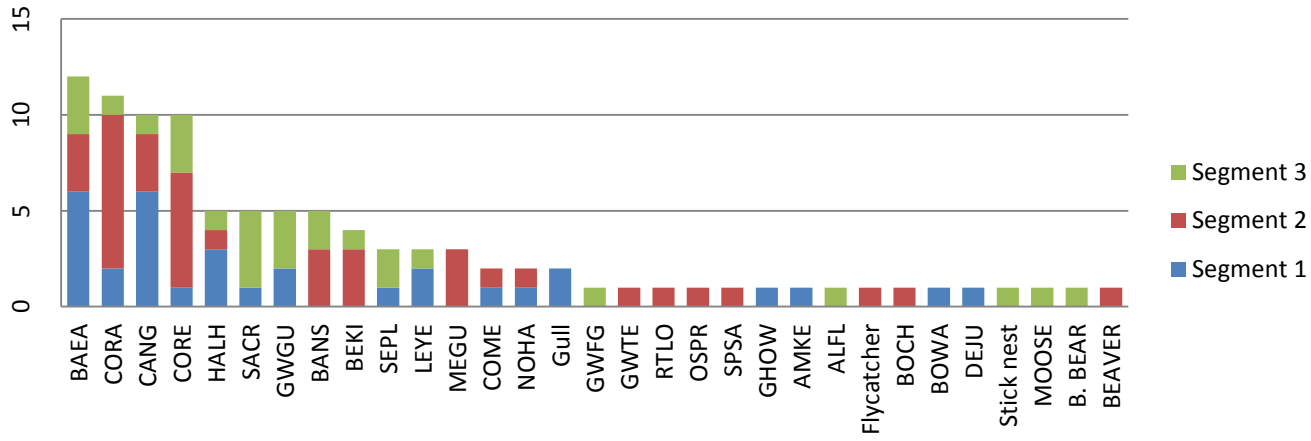

Figure 7. Nontarget species observed during a Northern Goshawk survey along 3 segments of Kanuti River in 2012. Kanuti National Wildife Refuge, Alaska.

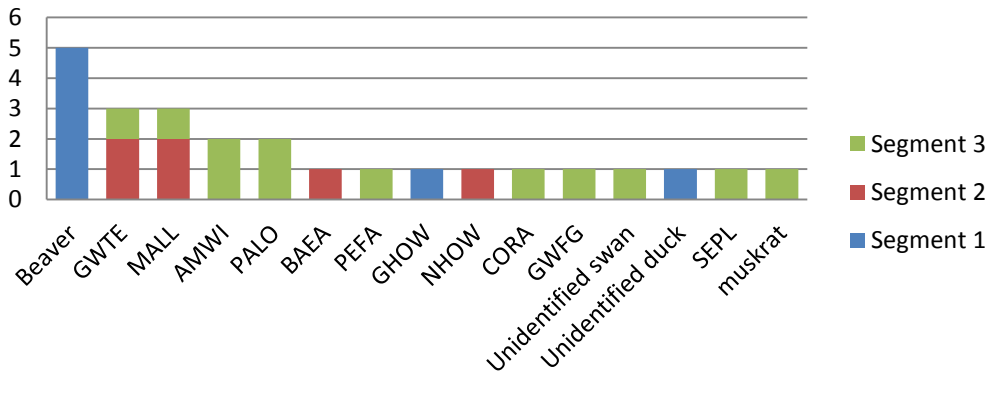

Table 3. Significant results of chi-square analysis of observations of non-target species along 3 segments of the Kanuti River in 2012. Kanuti National Wildlife Refuge, Alaska.			
Survey route	**Species**	**P value (α=0.05)**	**Comment**
Kanuti River	Total No. observations	0.049787	More species observed in segment 3

Observations of wildlife made while in transit to/from the Kanuti River.

We spotted 20 different species while traveling on the Main Koyukuk and Kanuti Rivers between Bettles, Alaska and the furthest spot that we reached upstream on Kanuti River (Arnica Hill; N66.21644 W151.37453). These included 6 species of waterfowl, 10 of raptors, 3 of mammals and 1 gamebird species. We also located or relocated 11 raptor nests, including several nests of Bald Eagles and Harlan's Hawks, several vacant raptor stick nests, and one nest each of Osprey, Great Horned Owl, Northern Hawk Owl and Peregrine Falcon. These data were not collected systematically and should be considered as opportunistic observations. Figure 8 presents the results of these observations by "taxon". The actual locations of the observations by species are contained in Appendix 3.

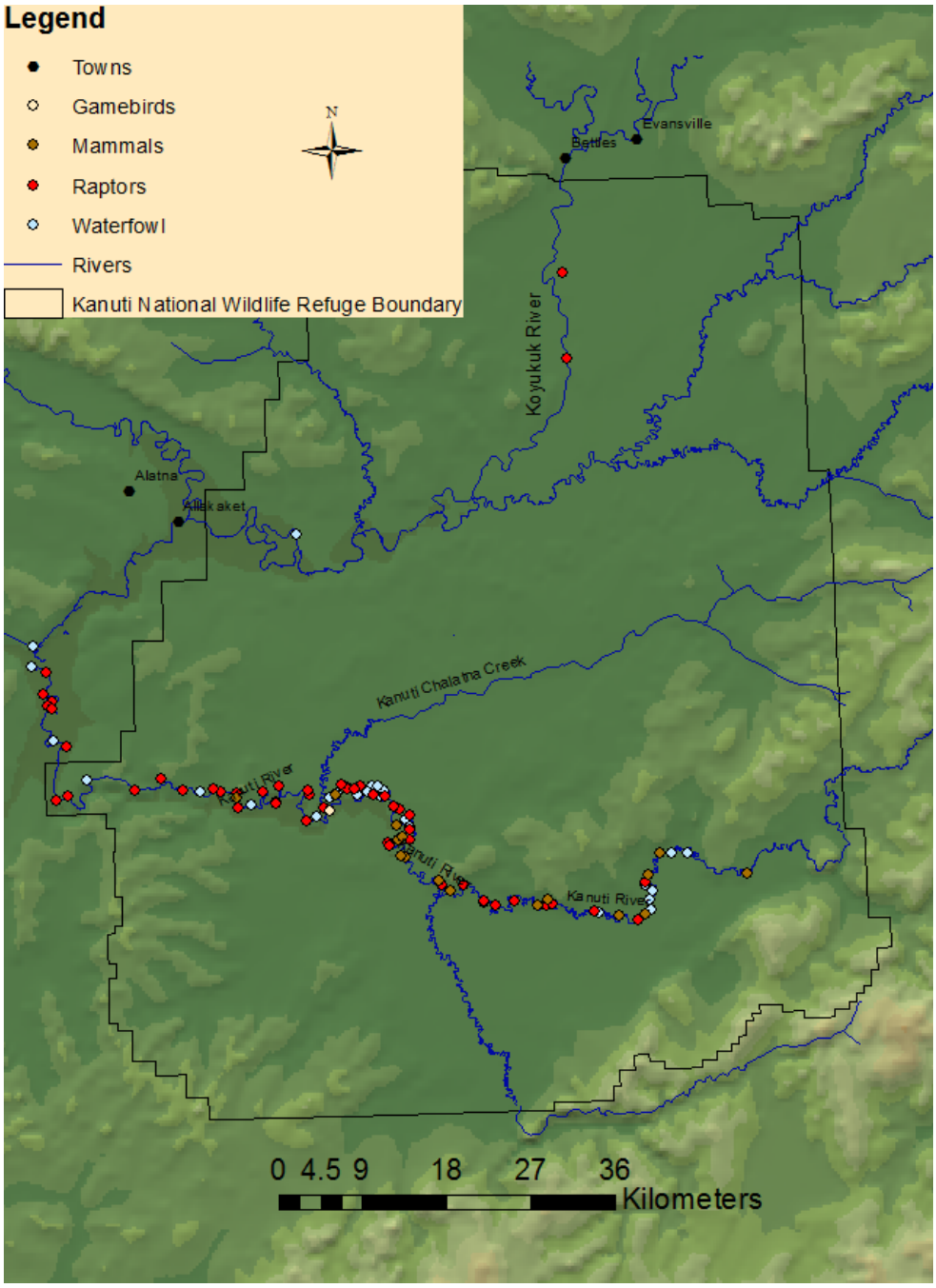

Figure 8. Opportunistic wildlife sightings, grouped by taxon, made along the Koyukuk and Kanuti River in mid-June, 2012 while in transit between Bettles, Alaska and the upper Kanuti River. Kanuti National Wildlife Refuge, Alaska.

Discussion

Because the sample sizes of responding goshawks along both survey routes are quite small, caution must be exercised in interpreting data. However, our results suggest that there may be a difference in the density of nesting goshawks between the survey routes. The lower relative density of responding, territorial goshawks on the South Fork Koyukuk/Jim River route compared to the shorter Kanuti River route may be explained in one of two ways. First, there

was a difference in timing between the two surveys. The earlier Kanuti River survey may have been conducted at a time more ideal for eliciting responses from nesting goshawks. Secondly, there are differences in habitat between the two areas; more area beyond the river corridors has burned in the South Fork/Jim River survey area than along the Kanuti River. This may have affected availability of prey for goshawks and resulted in a difference in nesting densities.

We elicited responses from Northern Goshawks at stations that were grouped close together in both of our survey areas. The responses we detected were within the mean nearest-neighbor distances between active goshawk nests reported in many other studies. Squires and Reynolds (1997) reported a mean distance of 3.0 and 3.3 km in Arizona and California, respectively. In Oregon, goshawks nested further apart, ca. 5.6 km between nests (Reynolds and Wright 1978). Selås (2006) found nearest neighboring nests to be 3.2 to 5.4 km apart in Norway, and attributed the variability to differences in prey availability (i.e., birds nested closer together where there was more prey). In the only study of goshawks in Alaska, McGown (1975) found active nests as close as 2.4 km apart on one occasion. Although he did not record mean inter-nest distances, McGown (1975) did document that the nesting density during three years of his study ranged from 41–372 km^2 per one pair in his study area around Fairbanks, Alaska. If one assumes that all of these territories were circular, the centers of the resulting territories would have been 7.2–21.8 km apart.

The literature reports of inter-nest distances for goshawks suggest that we may have elicited repeated responses from adults from the same territories during our surveys. In fact, if we attribute these clusters to responses by birds from the same territories, we may have only detected two goshawk nesting territories in the South Fork/Jim Rivers survey area and three in the Kanuti River survey route in 2012. If this is correct, Northern Goshawks may have responded to broadcast calls at stations that were up to 2.3 and 5.2 km apart on the Kanuti and South Fork/Jim River routes, respectively.

Goshawks are known to reuse the same nest in different years but can also use alternate nests in the same territory, some up to 400 m apart (Reynolds and Wright 1978). It is probable that at least one of the "clusters" of responses we elicited on Kanuti River in both 2011 and 2012 was by birds that showed fidelity to their nesting territory.

The significant difference in distribution of other species responding to our broadcast calls occurred in the segments on the Kanuti River in which goshawks also responded to our calls. The reason for this difference is unknown. However, one possible explanation is that species exposed to a resident predator, such as the goshawk, within their home range are more likely to 'recognize' the potential threat of a proximal predator and respond with an alarm call of their own. Differences in the distribution of species that we incidentally observed during surveys are likely related to differences in habitat along the rivers.

Recommendations

- We recommend that the South Fork Koyukuk/Jim River survey be repeated in 2013, but earlier in the summer than when the 2012 survey was conducted. We do not know the nesting phenology of goshawks on the Refuge. By conducting the survey earlier in the

summer, we may improve the response rate by territorial birds if there is a survey/phenology mismatch.

- We suggest that the Kanuti River survey route be extended upstream to begin near Arnica Hill (circa N66.216434, W151.37453).
- The USDA Forest Service (USFS) tested these survey techniques at known nesting areas and found that when one survey was conducted along a transect line in a season, response rates were 90% at active nests and 64% at occupied territories (i.e., where nests had failed or non-breeders were present; Woodbridge and Hargis 2006). In contrast, when two surveys were conducted along transects during the same nesting season, 94 percent of the active territories and 87 percent of occupied unsuccessful territories were detected. We recommend that the South Fork/ Jim Rivers survey route be conducted by two independent survey teams in 2013. The surveys should be conducted at least one day apart; both teams should have at least one experienced observer, including one person with good hearing. This will improve detection rates and allow us to determine a measure of error (Anthony et al. 1999).
- It appears that calling stations may be close enough together that we are repeatedly calling in birds from the same territory. Nonetheless, we suggest the same spacing be used in 2013 to determine if in fact the "clustering" effect occurs, again. The results of three seasons of work will dictate changes in station placement for future surveys.

Literature Citation

Anthony, R., M. Garret and F. Isaacs. 1999. Double-Survey Estimates of Bald Eagle Populations in Oregon. J. of Wildl. Manage. 63: 794-802

Craig, T. and M. Spindler. 2011. Northern Goshawk Survey on the Kanuti River, 2011. Unpublished report. Kanuti National Wildlife Refuge, US Fish and Wildlife Service, Fairbanks, Alaska 23 pp.

McGowan, J. D. 1975. Distribution, density and productivity of goshawks in interior Alaska. Proj. Rep. W-17-4, W17-5, W-17-6, Job 10.6A. Fed. Aid Wildl. Restor. Alaska Dep. of Fish and Game. 30 pp. and appendices.

Reynolds, R. T. and H. M. Wight. 1978. Distribution, density, and productivity of accipiter hawks breeding in Oregon. Wilson Bull. 90:182-196.

Rupp, T. S. and A. Springsteen. 2009. Summary Report for Kanuti National Wildlife Refuge. Projected Vegetation and Fire Regime Response to Future Climate Change in Alaska. Scenarios Network for Alaska Planning (SNAP), University of Alaska, Fairbanks. Fairbanks, Alaska. http://www.snap.uaf.edu/resource_page.php?resourceid=9

Selås, V. 1998. Does food competition from red fox (*Vulpes vulpes*) influence the breeding density of goshawks (*Accipiter gentilis*)? Evidence from a natural experiment. J. Zool., Lond. 246:325-335.

Squires, John R. and Richard T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/298doi:10.2173/bna.298

Woodbridge, B.and C. D. Hargis, C.D. 2006. Northern goshawk inventory and monitoring technical guide. Gen. Tech. Rep. WO-71. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 p.

Appendix 1. GPS locations of calling stations used on the South Fork/Jim River survey route

Id	Latitude	Longitude
001GR-1	66.78379	-151.12826
003GR-1	66.78211	-151.13535
005GR-1	66.78012	-151.14270
007GR-1	66.78220	-151.14835
009GR-1	66.78477	-151.15317
011GR-1	66.78471	-151.16171
012GR-1	66.78424	-151.16592
017GR-1	66.78169	-151.18593
018GR-1	66.78178	-151.19025
021GR-1	66.78583	-151.19526
023GR-1	66.78877	-151.19746
024GR-1	66.78958	-151.20116
028G	66.78730	-151.21377
029GR-1	66.78558	-151.21473
030GR-1	66.78406	-151.21707
034GR-2	66.78376	-151.23166
035GR-2	66.78555	-151.23187
037GR-2	66.78693	-151.23849
040GR-2	66.78206	-151.24257
041GR-2	66.78128	-151.24628
044GR-2	66.78013	-151.25725
046GR-2	66.77803	-151.26435
047GR-2	66.77697	-151.26798
049GR-2	66.77374	-151.27123
055GR-2	66.76590	-151.27324
058GR-2	66.77030	-151.27996
059GR-2	66.77139	-151.28338
062GR-2	66.77178	-151.29539
063GR-2	66.77048	-151.29852
067GR-2	66.76779	-151.31127
076GR-3	66.76650	-151.32635
077GR-3	66.76532	-151.33055
084GR-3	66.76249	-151.33130

085GR-3	66.75971	-151.33054
086GR-3	66.75794	-151.33632
090GR-3	66.75644	-151.35287
092GR-3	66.75323	-151.35425
093GR-3	66.75103	-151.35109
094GR-3	66.74882	-151.35971
114	66.72426	-151.37294
126GR-3	66.70623	-151.37857
127GR-3	66.70451	-151.37907
146G	66.68335	-151.41359
147GR-3	66.68095	-151.41040
149GR-3	66.67870	-151.41801
151GR-3	66.67622	-151.41794
156GR-4	66.67233	-151.42845
160G	66.66997	-151.44391
161GR-4	66.67030	-151.44931
163G	66.67331	-151.46376
164GR-4	66.67332	-151.46376
173G	66.66743	-151.46992
175GR-4	66.66296	-151.47701
176GR-4	66.66238	-151.47802
177GR-4	66.66208	-151.48630
179G	66.66515	-151.49088
184GR-4	66.66064	-151.50681
185GR-4	66.66081	-151.51132
186GR-4	66.66082	-151.51712
190GR-4	66.65727	-151.52021
191GR-4	66.65662	-151.51819
193GR-4	66.65554	-151.50767
194GR-4	66.65421	-151.50514
196GR-4	66.65034	-151.51204
197GR-5	66.64944	-151.51422
198GR-5	66.64939	-151.51483
199GR-5	66.64809	-151.51640
201G	66.64692	-151.51262
203G	66.64872	-151.49991
204GR-5	66.65121	-151.50049
205GR-5	66.65289	-151.49796
208GR-5	66.65259	-151.48683
209GR-5	66.65054	-151.48476
210GR-5	66.64882	-151.48369

214GR-5	66.64576	-151.49948
215GR-5	66.64460	-151.49867
226GR-5	66.63822	-151.50824
227GR-5	66.63639	-151.50414
230GR-5	66.63263	-151.49577
232GR-5	66.63285	-151.50688
233GR-5	66.63442	-151.51308
234GR-5	66.63425	-151.51463
235GR-5	66.63395	-151.51678
238GR-6	66.63021	-151.51862
240GR-6	66.62708	-151.52003
242GR-6	66.62933	-151.52849
249GR-6	66.62508	-151.54636
250GR-6	66.62412	-151.54253
251GR-6	66.62460	-151.53696
255GR-6	66.62135	-151.53900
256GR-6	66.62226	-151.54378
257GR-6	66.62209	-151.54869
258GR-6	66.62296	-151.55618
259GR-6	66.62320	-151.56082
262GR-6	66.62218	-151.59027
269GR-6	66.62073	-151.58177
270GR-6	66.61842	-151.57915
272GR-6	66.61719	-151.59125
275GR-6	66.61390	-151.60109
277GR-6	66.61230	-151.60526
283GR-7	66.60564	-151.58989
287GR-7	66.60477	-151.59723
289GR-7	66.60678	-151.60500
290GR-7	66.60689	-151.60755
292GR-7	66.60993	-151.61664
293GR-7	66.61098	-151.62119
296GR-7	66.61234	-151.63411
297GR-7	66.61268	-151.63857
300GR-7	66.61398	-151.64897
305GR-7	66.62155	-151.64700
309GR-7	66.61789	-151.65927
311GR-7	66.61417	-151.65697
312GR-7	66.61214	-151.65604
313GR-7	66.61032	-151.65688
315GR-7	66.60708	-151.66068

316GR-7	66.6069	-151.66489
318GR-7	66.60828	-151.67340
324GR-8	66.60708	-151.68129
326GR-8	66.60336	-151.67693
327GR-8	66.60127	-151.67807
329GR-8	66.59996	-151.68546
343GR-8	66.59872	-151.69917
344GR-8	66.59972	-151.70282
346GR-8	66.59782	-151.70903
349GR-8	66.59293	-151.70622
352GR-8	66.59246	-151.71645
353GR-8	66.54426	-151. 1785
354GR-8	66.596	-151.71892
355GR-8	66.59616	-151.72089
363G	66.58921	-151.74763
364GR-9	66.58729	-151.74818
366GR-9	66.58436	-151.74869
367GR-9	66.58332	-151.74446
368GR-9	66.58165	-151.74254
370GR-9	66.57878	-151.74384
371GR-9	66.57849	-151.75063
376GR-9	66.57676	-151.75119
380GR-9	66.5732	-151.76685
381GR-9	66.57381	-151.77271
389GR-9	66.57374	-151.79320
390GR-9	66.5751	-151.79951
391GR-9	66.57533	-151.80397
392GR-9	66.57617	-151.80804
393GR-9	66.57719	-151.81013
398GR-9	66.58360	-151.81573
399GR-9	66.58272	-151.81615
400GR-9	66.5815	-151.82201
403GR-10	66.5775	-151.82883
404GR-10	66.57638	-151.83270
405GR-10	66.57616	-151.83562
406GR-10	66.57615	-151.84343
411GR-10	66.58253	-151.84798
413GR-10	66.5815	-151.85556
414GR-10	66.58110	-151.86079
417GR-10	66.57749	-151.86734
418G	66.57551	-151.86609

421GR-10	66.57139	-151.86508
423GR-10	66.56775	-151.86858
424GR-10	66.56767	-151.87523
427GR-10	66.56992	-151.88576
430GR-10	66.57267	-151.89687
431GR-10	66.57439	-151.89786
432GR-10	66.57650	-151.89746
437GR-10	66.58167	-151.91254

Appendix 2. Scientific names and species codes used in this report

English Name	4-Letter Code	Scientific Name
Birds		
Alder Flycatcher	ALFL	*Empidonax alnorum*
American Kestrel	AMKE	*Falco sparverius*
American Robin	AMRO	*Turdus migratorius*
American Wigeon	AMWI	*Anas americana*
Bald Eagle	BAEA	*Haliaeetus leucocephalus*
Bank Swallow	BANS	*Riparia riparia*
Belted Kingfisher	BEKI	*Megaceryle alcyon*
Bohemian Waxwing	BOWA	Bombycilla garrulus
Boreal Chickadee	BOCH	*Poecile hudsonicus*
Canada Goose	CANG	*Branta Canadensis*
Common merganser	COME	*Mergus merganser*
Common Raven	CORA	*Corvus corax*
Dark-eyed Junco	DEJU	*Junco hyemalis*
Glaucous-winged Gull	GWGU	*Larus glaucescens*
Gray Jay	GRAJ	*Perisoreus canadensis*
Great Gray Owl	GGOW	*Strix nebulosa*
Great Horned Owl	GHOW	*Bubo virginianus*
Greater White-front goose	GWFG	*Anser albifrons*
Green-winged Teal	GWTE	*Anas crecca*
Harlan's Hawk	HALH	*Buteo jamacensis harlani*
Lesser Yellowlegs	LEYE	*Tringa flavipes*
Merlin	MERL	*Falco columbarius*
Mew Gull	MEGU	*Larus canus*
Northern Goshawk	NOGO	*Accipiter gentilis*
Northern Flicker	NOFL	*Colaptes auratus*
Northern Harrier	NOHA	*Circus cyaneus*
Northern Hawk Owl	NHOW	*Surnia ulula*
Osprey	OSPR	*Pandion haliaetus*
Peregrine Falcon	PEFA	*Falco peregrinus*
Red-throated Loon	RTLO	*Gavia stellata*
Rusty Blackbird	RUBL	*Euphagus carolinus*
Sandhill Crane	SACR	*Grus canadensis*
Semipalmated plover	SEPL	*Charadrius semipalmatus*
Spotted Sandpiper	SPSA	*Actitis macularius*
Swainson's Thrush	SWTH	*Catharus ustulatus*
White-winged Crossbill	WWCR	*Loxia leucoptera*
Mammals		
Beaver	Beaver	*Castor canadensis*
Moose	Moose	*Alces alces*
Red Squirrel	Red Squirrel	*Tamiasciurus hudsonicus*

Appendix 3. Wildlife sightings made in mid-June, 2012 while in transit between Bettles, Alaska and Arnica Hill along Kanuti River. Kanuti National Wildlife Refuge, Alaska.

Latitude	Longitude	DATE	SPECIES	NUMBER	AGE (Adult/Young)	Group
66.28398	-152.30244	6/23/2012	SPGR	1	A	Gamebird
66.28398	-152.30244	6/23/2012	SPGR	4	Y	Gamebird
66.29814	-152.28610	6/18/2012	MOOSE	1	A	Mammal
66.29814	-152.28610	6/18/2012	MOOSE	1	Y	Mammal
66.26782	-152.14311	6/18/2012	MOOSE	1	A	Mammal
66.26782	-152.14311	6/18/2012	MOOSE	1	Y	Mammal
66.17468	-151.62233	6/19/2012	MOOSE	1	Y	Mammal
66.17431	-151.55777	6/19/2012	MOOSE	1	A	Mammal
66.21266	-151.55057	6/19/2012	MOOSE	2	A	Mammal
66.21266	-151.55057	6/19/2012	MOOSE	1	Y	Mammal
66.23291	-151.52044	6/19/2012	MOOSE	1	A	Mammal
66.23291	-151.52044	6/19/2012	MOOSE	2	Y	Mammal
66.21022	-151.31328	6/19/2012	MOOSE	1	Y	Mammal
66.19158	-151.79062	6/21/2012	BEAVER	4	A	Mammal
66.18704	-151.81433	6/21/2012	MOOSE	1	A	Mammal
66.18704	-151.81433	6/21/2012	MOOSE	2	Y	Mammal
66.20371	-152.01992	6/21/2012	MOOSE	1	A	Mammal
66.21337	-152.04624	6/22/2012	MOOSE	1	A	Mammal
66.21337	-152.04624	6/22/2012	MOOSE	1	Y	Mammal
66.23625	-152.12276	6/22/2012	MOOSE	1	A	Mammal
66.23625	-152.12276	6/22/2012	MOOSE	1	Y	Mammal
66.23773	-152.13521	6/22/2012	MOOSE	1	A	Mammal
66.25360	-152.14095	6/22/2012	MOOSE	1	Y	Mammal
66.25594	-152.12821	6/22/2012	MOOSE	1	A	Mammal
66.25594	-152.12821	6/22/2012	MOOSE	1	Y	Mammal
66.29872	-152.52107	6/23/2012	LYNX	1	A	Mammal
66.79527	-151.70296	6/17/2012	HALH nest	1		Raptor
66.71277	-151.70042	6/17/2012	PEFA nest	2		Raptor
66.40160	-152.97765	6/17/2012	GHOW	1	A	Raptor
66.39451	-152.95806	6/17/2012	BAEA	1	A	Raptor
66.39000	-152.96970	6/17/2012	BAEA nest	1		Raptor
66.39000	-152.96970	6/17/2012	GHOW	1	A	Raptor
66.30269	-152.46008	6/18/2012	PEFA	1	A	Raptor

66.29122	-152.42993	6/18/2012	GHOW	1	A	Raptor
66.29958	-152.34948	6/18/2012	GHOW	1	A	Raptor
66.28592	-152.14993	6/18/2012	OSPR nest	2		Raptor
66.26347	-152.11231	6/18/2012	HALH nest	2		Raptor
66.26347	-152.11231	6/18/2012	HALH	2	Y	Raptor
66.20841	-152.03982	6/19/2012	PEFA	2	A	Raptor
66.20830	-151.98721	6/19/2012	HALH nest		Vacant	Raptor
66.18795	-151.91408	6/19/2012	HALH nest		Vacant	Raptor
66.19160	-151.87016	6/19/2012	HALH nest	1		Raptor
66.19160	-151.87016	6/19/2012	HALH	1	Y	Raptor
66.18560	-151.79352	6/19/2012	BAEA	1	A	Raptor
66.18806	-151.77843	6/19/2012	GHOW	1	A	Raptor
66.17870	-151.68001	6/19/2012	BAEA	1	A	Raptor
66.17468	-151.62233	6/19/2012	GHOW	1	A	Raptor
66.16914	-151.57827	6/19/2012	NHOW	1	A	Raptor
66.20494	-151.55834	6/19/2012	GHOW	1	A	Raptor
66.19169	-151.94047	6/21/2012	NHOW	1	A	Raptor
66.19262	-151.94107	6/21/2012	NHOW	3	Y	Raptor
66.24869	-152.16238	6/22/2012	NOHA	1	A	Raptor
66.25142	-152.16344	6/22/2012	GGOW	1	A	Raptor
66.25353	-152.11328	6/22/2012	NHOW	1	A	Raptor
66.27775	-152.11218	6/22/2012	SSHA	1	A	Raptor
66.28309	-152.13603	6/22/2012	NHOW	1	A	Raptor
66.29619	-152.16850	6/22/2012	OSPR	1	A	Raptor
66.29779	-152.19733	6/23/2012	BAEA nest	1		Raptor
66.30678	-152.22732	6/23/2012	GHOW	1	A	Raptor
66.30408	-152.24111	6/23/2012	NHOW	2	A	Raptor
66.30351	-152.25949	6/23/2012	GHOW	1	A	Raptor
66.30778	-152.27105	6/23/2012	HALH	1	A	Raptor
66.28622	-152.31578	6/23/2012	GHOW	1	A	Raptor
66.27390	-152.35573	6/23/2012	GHOW	1	A	Raptor
66.30419	-152.35124	6/23/2012	GHOW	1	A	Raptor
66.30419	-152.35124	6/23/2012	AMKE	1	A	Raptor
66.30849	-152.42061	6/23/2012	GHOW	1	A	Raptor
66.30849	-152.42061	6/23/2012	MERL	1	A	Raptor

66.28885	-152.51699	6/23/2012	PEFA	2	A	Raptor
66.30297	-152.52123	6/23/2012	GHOW nest		Vacant	Raptor
66.30429	-152.55945	6/23/2012	GHOW	1	A	Raptor
66.30673	-152.57656	6/23/2012	GHOW	2	A	Raptor
66.30653	-152.64872	6/23/2012	GHOW	1	A	Raptor
66.31850	-152.70100	6/23/2012	GHOW	2	A	Raptor
66.30749	-152.76522	6/23/2012	GHOW	1	A	Raptor
66.30263	-152.92318	6/23/2012	Stick Nest		Vacant	Raptor
66.29890	-152.95018	6/23/2012	GHOW	1	A	Raptor
66.35055	-152.92608	6/23/2012	GHOW	1	A	Raptor
66.35055	-152.92608	6/23/2012	Stick Nest		Vacant	Raptor
66.38665	-152.95661	6/23/2012	OSPR	1	A	Raptor
66.42280	-152.97205	6/23/2012	GHOW	1	A	Raptor
66.40160	-152.97765	6/17/2012	GWFG	4	A	Waterfowl
66.40160	-152.97765	6/17/2012	GWFG	8	Y	Waterfowl
66.39000	-152.96970	6/17/2012	GWTE	20		Waterfowl
66.30509	-152.25958	6/18/2012	CANG	16	Y	Waterfowl
66.30509	-152.25958	6/18/2012	SWAN	2	A	Waterfowl
66.29557	-152.17815	6/18/2012	CANG	23	Y	Waterfowl
66.29557	-152.17815	6/18/2012	CANG	7	A	Waterfowl
66.28592	-152.14993	6/18/2012	CANG	6	Y	Waterfowl
66.26636	-152.11264	6/18/2012	GWFG	6	Y	Waterfowl
66.17763	-151.67058	6/19/2012	GWTE	9	Y	Waterfowl
66.17468	-151.62233	6/19/2012	GWFG	5	Y	Waterfowl
66.17431	-151.55777	6/19/2012	GWFG	4	Y	Waterfowl
66.18790	-151.54848	6/19/2012	CANG	6	Y	Waterfowl
66.19669	-151.53852	6/19/2012	CANG	4	Y	Waterfowl
66.20251	-151.55627	6/19/2012	CANG	3	Y	Waterfowl
66.23195	-151.49270	6/19/2012	CANG	8	Y	Waterfowl
66.23206	-151.45425	6/19/2012	CANG	16	Y	Waterfowl
66.17863	-151.54465	6/19/2012	CANG	9	Y	Waterfowl
66.23749	-152.13466	6/22/2012	GWFG	6	Y	Waterfowl
66.27282	-152.12184	6/22/2012	CANG	6	Y	Waterfowl
66.29619	-152.16850	6/22/2012	GWFG	4	Y	Waterfowl
66.30175	-152.17094	6/23/2012	CANG	25	Y	Waterfowl
66.30533	-152.18463	6/23/2012	GWFG	14	Y	Waterfowl
66.30533	-152.18463	6/23/2012	CANG	5	Y	Waterfowl
66.30672	-152.19855	6/23/2012	CANG	8	Y	Waterfowl
66.30135	-152.21055	6/23/2012	GWFG	7	Y	Waterfowl

66.29844	-152.23283	6/23/2012	CANG	40	Y	Waterfowl
66.30351	-152.25949	6/23/2012	CANG	14	Y	Waterfowl
66.30026	-152.28074	6/23/2012	AMWI	16	Y	Waterfowl
66.29554	-152.29851	6/23/2012	GWFG	8	Y	Waterfowl
66.27839	-152.33274	6/23/2012	CANG	13	Y	Waterfowl
66.29271	-152.42731	6/23/2012	MALL	6	Y	Waterfowl
66.29122	-152.48855	6/23/2012	GWFG	4	Y	Waterfowl
66.30393	-152.60892	6/23/2012	GWFG	7	Y	Waterfowl
66.31817	-152.87805	6/23/2012	GWFG	4	Y	Waterfowl
66.35643	-152.95735	6/23/2012	GWFG	16	Y	Waterfowl
66.42819	-153.00453	6/23/2012	CANG	4	Y	Waterfowl
66.44723	-152.99957	6/23/2012	CANG	4	Y	Waterfowl
66.55077	-152.36509	6/23/2012	CANG	6	Y	Waterfowl